



9-Mbit (256K x 36/512K x 18) Pipelined DCD Sync SRAM

Features

- Supports bus operation up to 250 MHz
- Available speed grades are 250, 200, and 166 MHz
- Registered inputs and outputs for pipelined operation
- Optimal for performance (Double-Cycle deselect)
 - Depth expansion without wait state
- 3.3V -5% and +10% core power supply (V_{DD})
- 2.5 V/3.3V I/O power supply (V_{DDQ})
- Fast clock-to-output times
 - 2.8 ns (for 250-MHz device)
- Provide high-performance 3-1-1-1 access rate
- User-selectable burst counter supporting Intel® Pentium® interleaved or linear burst sequences
- Separate processor and controller address strobes
- Synchronous self-timed writes
- Asynchronous output enable
- Available in lead-free 100-Pin TQFP, lead-free and non lead-free 119-Ball BGA package and 165-Ball FBGA package
- IEEE 1149.1 JTAG-Compatible Boundary Scan
- “ZZ” Sleep Mode Option

Functional Description^[1]

The CY7C1366C/CY7C1367C SRAM integrates 256K x 36 and 512K x 18 SRAM cells with advanced synchronous peripheral circuitry and a two-bit counter for internal burst operation. All synchronous inputs are gated by registers controlled by a positive-edge-triggered Clock Input (CLK). The synchronous inputs include all addresses, all data inputs, address-pipelining Chip Enable (CE_1), depth-expansion Chip Enables (CE_2 and CE_3 ^[2]), Burst Control inputs (ADSC, ADSP, and ADV), Write Enables (BW_X and BWE), and Global Write (GW). Asynchronous inputs include the Output Enable (OE) and the ZZ pin.

Addresses and chip enables are registered at rising edge of clock when either Address Strobe Processor (ADSP) or Address Strobe Controller (ADSC) are active. Subsequent burst addresses can be internally generated as controlled by the Advance pin (ADV).

Address, data inputs, and write controls are registered on-chip to initiate a self-timed Write cycle. This part supports Byte Write operations (see Pin Descriptions and Truth Table for further details). Write cycles can be one to four bytes wide as controlled by the byte write control inputs. \overline{GW} active LOW causes all bytes to be written. This device incorporates an additional pipelined enable register which delays turning off the output buffers an additional cycle when a deselect is executed. This feature allows depth expansion without penalizing system performance.

The CY7C1366C/CY7C1367C operates from a +3.3V core power supply while all outputs operate with a +3.3V or a +2.5V supply. All inputs and outputs are JEDEC-standard JESD8-5-compatible.

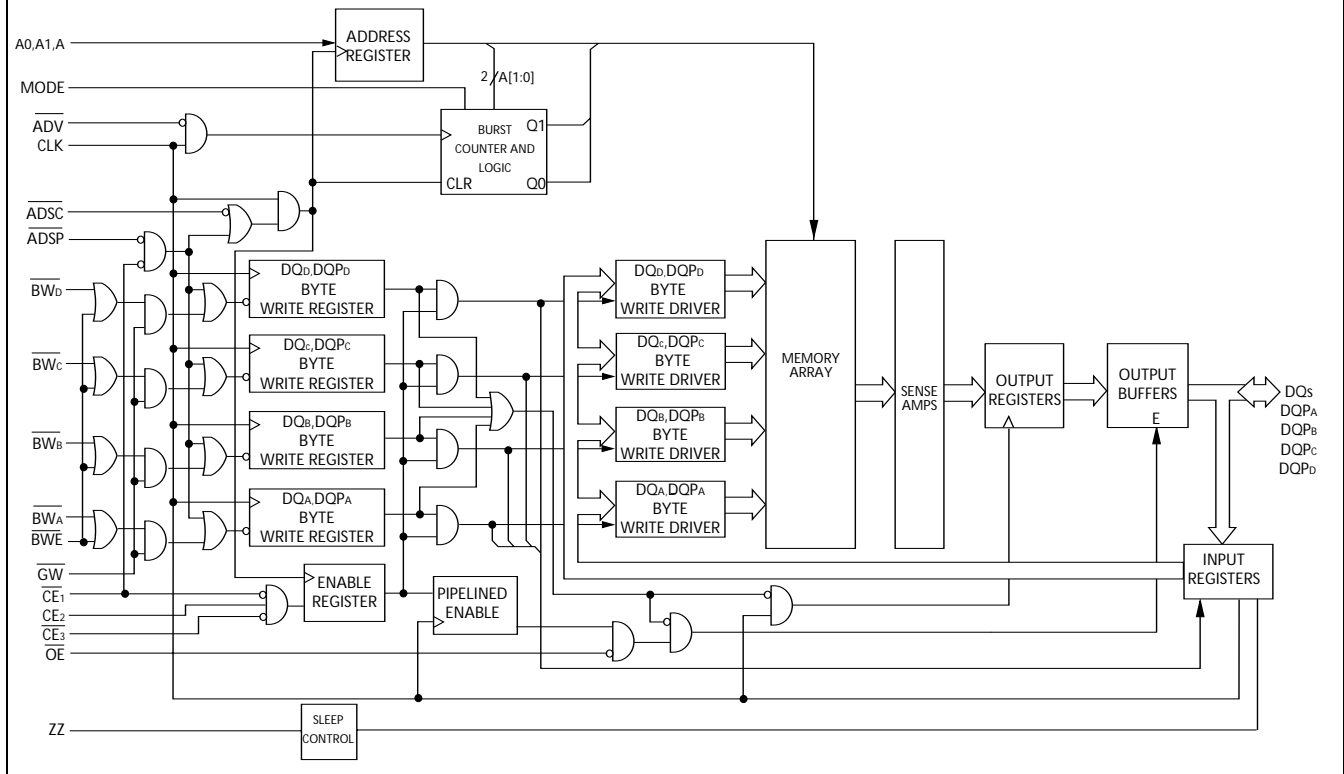
Selection Guide

	250 MHz	200 MHz	166 MHz	Unit
Maximum Access Time	2.8	3.0	3.5	ns
Maximum Operating Current	250	220	180	mA
Maximum CMOS Standby Current	40	40	40	mA

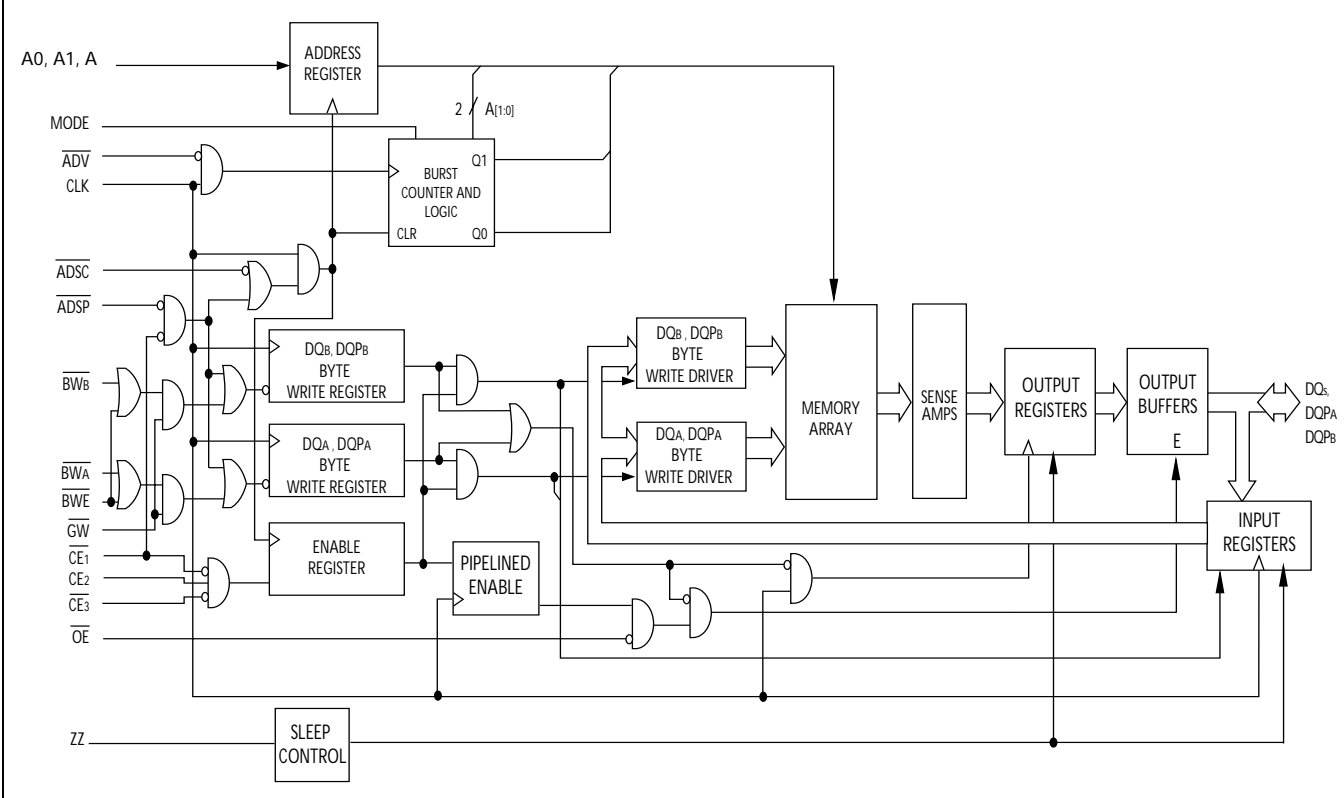
Notes:

1. For best-practices recommendations, please refer to the Cypress application note *System Design Guidelines* on www.cypress.com.
2. CE_3 is for TQFP and 165 FBGA package only. 119 BGA is offered only in 2 Chip Enable.

Logic Block Diagram – CY7C1366C (256K x 36)



Logic Block Diagram – CY7C1367C (512K x 18)



Pin Configurations (continued)

119-Ball BGA Pinout (2 Chip Enable with JTAG)
CY7C1366C (256K x 36)

	1	2	3	4	5	6	7
A	V _{DDQ}	A	A	$\overline{\text{ADSP}}$	A	A	V _{DDQ}
B	NC/288M	CE ₂	A	$\overline{\text{ADSC}}$	A	A	NC/576M
C	NC/144M	A	A	V _{DD}	A	A	NC/1G
D	DQ _C	DQP _C	V _{SS}	NC	V _{SS}	DQP _B	DQ _B
E	DQ _C	DQ _C	V _{SS}	$\overline{\text{CE}}_1$	V _{SS}	DQ _B	DQ _B
F	V _{DDQ}	DQ _C	V _{SS}	$\overline{\text{OE}}$	V _{SS}	DQ _B	V _{DDQ}
G	DQ _C	DQ _C	$\overline{\text{BW}}_C$	$\overline{\text{ADV}}$	$\overline{\text{BW}}_B$	DQ _B	DQ _B
H	DQ _C	DQ _C	V _{SS}	$\overline{\text{GW}}$	V _{SS}	DQ _B	DQ _B
J	V _{DDQ}	V _{DD}	NC	V _{DD}	NC	V _{DD}	V _{DDQ}
K	DQ _D	DQ _D	V _{SS}	CLK	V _{SS}	DQ _A	DQ _A
L	DQ _D	DQ _D	$\overline{\text{BW}}_D$	NC	$\overline{\text{BW}}_A$	DQ _A	DQ _A
M	V _{DDQ}	DQ _D	V _{SS}	$\overline{\text{BWE}}$	V _{SS}	DQ _A	V _{DDQ}
N	DQ _D	DQ _D	V _{SS}	A1	V _{SS}	DQ _A	DQ _A
P	DQ _D	DQP _D	V _{SS}	A0	V _{SS}	DQP _A	DQ _A
R	NC	A	MODE	V _{DD}	NC	A	NC
T	NC	NC/72M	A	A	A	NC/36M	ZZ
U	V _{DDQ}	TMS	TDI	TCK	TDO	NC	V _{DDQ}

CY7C1367C (512K x 18)

	1	2	3	4	5	6	7
A	V _{DDQ}	A	A	$\overline{\text{ADSP}}$	A	A	V _{DDQ}
B	NC/288M	CE ₂	A	$\overline{\text{ADSC}}$	A	A	NC/576M
C	NC/144M	A	A	V _{DD}	A	A	NC/1G
D	DQ _B	NC	V _{SS}	NC	V _{SS}	DQP _A	NC
E	NC	DQ _B	V _{SS}	$\overline{\text{CE}}_1$	V _{SS}	NC	DQ _A
F	V _{DDQ}	NC	V _{SS}	$\overline{\text{OE}}$	V _{SS}	DQ _A	V _{DDQ}
G	NC	DQ _B	$\overline{\text{BW}}_B$	$\overline{\text{ADV}}$	V _{SS}	NC	DQ _A
H	DQ _B	NC	V _{SS}	$\overline{\text{GW}}$	V _{SS}	DQ _A	NC
J	V _{DDQ}	V _{DD}	NC	V _{DD}	NC	V _{DD}	V _{DDQ}
K	NC	DQ _B	V _{SS}	CLK	V _{SS}	NC	DQ _A
L	DQ _B	NC	V _{SS}	NC	$\overline{\text{BW}}_A$	DQ _A	NC
M	V _{DDQ}	DQ _B	V _{SS}	$\overline{\text{BWE}}$	V _{SS}	NC	V _{DDQ}
N	DQ _B	NC	V _{SS}	A1	V _{SS}	DQ _A	NC
P	NC	DQP _B	V _{SS}	A0	V _{SS}	NC	DQ _A
R	NC	A	MODE	V _{DD}	NC	A	NC
T	NC/72M	A	A	NC/36M	A	A	ZZ
U	V _{DDQ}	TMS	TDI	TCK	TDO	NC	V _{DDQ}

Pin Configurations (continued)

165-ball FBGA Pinout (3 Chip Enable)
CY7C1366C (256K x 36)

	1	2	3	4	5	6	7	8	9	10	11
A	NC/288M	A	\overline{CE}_1	\overline{BW}_C	\overline{BW}_B	\overline{CE}_3	\overline{BWE}	\overline{ADSC}	\overline{ADV}	A	NC
B	NC/144M	A	CE_2	\overline{BW}_D	\overline{BW}_A	CLK	\overline{GW}	\overline{OE}	\overline{ADSP}	A	NC/576M
C	DQP _C	NC	V _{DDQ}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{DDQ}	NC/1G	DQP _B
D	DQ _C	DQ _C	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _B	DQ _B
E	DQ _C	DQ _C	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _B	DQ _B
F	DQ _C	DQ _C	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _B	DQ _B
G	DQ _C	DQ _C	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _B	DQ _B
H	NC	V _{SS}	NC	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	NC	NC	ZZ
J	DQ _D	DQ _D	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	DQ _A
K	DQ _D	DQ _D	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	DQ _A
L	DQ _D	DQ _D	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	DQ _A
M	DQ _D	DQ _D	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	DQ _A
N	DQP _D	NC	V _{DDQ}	V _{SS}	NC	NC/18M	NC	V _{SS}	V _{DDQ}	NC	DQP _A
P	NC	NC/72M	A	A	TDI	A1	TDO	A	A	A	A
R	MODE	NC/36M	A	A	TMS	A0	TCK	A	A	A	A

CY7C1367C (512K x 18)

	1	2	3	4	5	6	7	8	9	10	11
A	NC/288M	A	\overline{CE}_1	\overline{BW}_B	NC	\overline{CE}_3	\overline{BWE}	\overline{ADSC}	\overline{ADV}	A	A
B	NC/144M	A	CE_2	NC	\overline{BW}_A	CLK	\overline{GW}	\overline{OE}	\overline{ADSP}	A	NC/576M
C	NC	NC	V _{DDQ}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{SS}	V _{DDQ}	NC/1G	DQP _A
D	NC	DQ _B	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	NC	DQ _A
E	NC	DQ _B	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	NC	DQ _A
F	NC	DQ _B	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	NC	DQ _A
G	NC	DQ _B	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	NC	DQ _A
H	NC	V _{SS}	NC	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	NC	NC	ZZ
J	DQ _B	NC	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	NC
K	DQ _B	NC	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	NC
L	DQ _B	NC	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	NC
M	DQ _B	NC	V _{DDQ}	V _{DD}	V _{SS}	V _{SS}	V _{SS}	V _{DD}	V _{DDQ}	DQ _A	NC
N	DQP _B	NC	V _{DDQ}	V _{SS}	NC	NC/18M	NC	V _{SS}	V _{DDQ}	NC	NC
P	NC	NC/72M	A	A	TDI	A1	TDO	A	A	A	A
R	MODE	NC/36M	A	A	TMS	A0	TCK	A	A	A	A

Pin Definitions

Name	I/O	Description
A ₀ , A ₁ , A	Input-Synchronous	Address Inputs used to select one of the address locations. Sampled at the rising edge of the CLK if ADSP or ADSC is active LOW, and CE ₁ , CE ₂ , and CE ₃ ^[2] are sampled active. A1: A0 are fed to the two-bit counter.
$\overline{BW}_A, \overline{BW}_B$ $\overline{BW}_C, \overline{BW}_D$	Input-Synchronous	Byte Write Select Inputs, active LOW. Qualified with \overline{BWE} to conduct byte writes to the SRAM. Sampled on the rising edge of CLK.
GW	Input-Synchronous	Global Write Enable Input, active LOW. When asserted LOW on the rising edge of CLK, a global write is conducted (ALL bytes are written, regardless of the values on BW _x and BWE).
BWE	Input-Synchronous	Byte Write Enable Input, active LOW. Sampled on the rising edge of CLK. This signal must be asserted LOW to conduct a byte write.
CLK	Input-Clock	Clock Input. Used to capture all synchronous inputs to the device. Also used to increment the burst counter when ADV is asserted LOW, during a burst operation.
CE ₁	Input-Synchronous	Chip Enable 1 Input, active LOW. Sampled on the rising edge of CLK. Used in conjunction with CE ₂ and CE ₃ ^[2] to select/deselect the device. ADSP is ignored if CE ₁ is HIGH. CE ₁ is sampled only when a new external address is loaded.
CE ₂	Input-Synchronous	Chip Enable 2 Input, active HIGH. Sampled on the rising edge of CLK. Used in conjunction with CE ₁ and CE ₃ ^[2] to select/deselect the device. CE ₂ is sampled only when a new external address is loaded.
CE ₃ ^[2]	Input-Synchronous	Chip Enable 3 Input, active LOW. Sampled on the rising edge of CLK. Used in conjunction with CE ₁ and CE ₂ to select/deselect the device. Not connected for BGA. Where referenced, CE ₃ ^[2] is assumed active throughout this document for BGA. CE ₃ is sampled only when a new external address is loaded.
OE	Input-Asynchronous	Output Enable, asynchronous input, active LOW. Controls the direction of the I/O pins. When LOW, the I/O pins behave as outputs. When deasserted HIGH, DQ pins are tri-stated, and act as input data pins. OE is masked during the first clock of a read cycle when emerging from a deselected state.
ADV	Input-Synchronous	Advance Input signal, sampled on the rising edge of CLK, active LOW. When asserted, it automatically increments the address in a burst cycle.
ADSP	Input-Synchronous	Address Strobe from Processor, sampled on the rising edge of CLK, active LOW. When asserted LOW, addresses presented to the device are captured in the address registers. A1: A0 are also loaded into the burst counter. When ADSP and ADSC are both asserted, only ADSP is recognized. ADSP is ignored when CE ₁ is deasserted HIGH.
ADSC	Input-Synchronous	Address Strobe from Controller, sampled on the rising edge of CLK, active LOW. When asserted LOW, addresses presented to the device are captured in the address registers. A1: A0 are also loaded into the burst counter. When ADSP and ADSC are both asserted, only ADSP is recognized.
ZZ	Input-Asynchronous	ZZ “sleep” Input, active HIGH. When asserted HIGH places the device in a non-time-critical “sleep” condition with data integrity preserved. For normal operation, this pin has to be LOW or left floating. ZZ pin has an internal pull-down.
DQs, DQPs	I/O-Synchronous	Bidirectional Data I/O lines. As inputs, they feed into an on-chip data register that is triggered by the rising edge of CLK. As outputs, they deliver the data contained in the memory location specified by the addresses presented during the previous clock rise of the read cycle. The direction of the pins is controlled by OE. When OE is asserted LOW, the pins behave as outputs. When HIGH, DQs and DQP _x are placed in a tri-state condition.
V _{DD}	Power Supply	Power supply inputs to the core of the device.
V _{SS}	Ground	Ground for the core of the device.
V _{SSQ}	I/O Ground	Ground for the I/O circuitry.
V _{DDQ}	I/O Power Supply	Power supply for the I/O circuitry.
MODE	Input-Static	Selects Burst Order. When tied to GND selects linear burst sequence. When tied to V _{DD} or left floating selects interleaved burst sequence. This is a strap pin and should remain static during device operation. Mode Pin has an internal pull-up.

Pin Definitions (continued)

Name	I/O	Description
TDO	JTAG serial output Synchronous	Serial data-out to the JTAG circuit. Delivers data on the negative edge of TCK. If the JTAG feature is not being utilized, this pin should be disconnected. This pin is not available on TQFP packages.
TDI	JTAG serial input Synchronous	Serial data-In to the JTAG circuit. Sampled on the rising edge of TCK. If the JTAG feature is not being utilized, this pin can be disconnected or connected to V _{DD} . This pin is not available on TQFP packages.
TMS	JTAG serial input Synchronous	Serial data-In to the JTAG circuit. Sampled on the rising edge of TCK. If the JTAG feature is not being utilized, this pin can be disconnected or connected to V _{DD} . This pin is not available on TQFP packages.
TCK	JTAG- Clock	Clock input to the JTAG circuitry. If the JTAG feature is not being utilized, this pin must be connected to V _{SS} . This pin is not available on TQFP packages.
NC	–	No Connects. Not internally connected to the die. 18M, 36M, 72M, 144M, 288M, 576M, and 1G are address expansion pins and are not internally connected to the die.

Functional Overview

All synchronous inputs pass through input registers controlled by the rising edge of the clock. All data outputs pass through output registers controlled by the rising edge of the clock.

The CY7C1366C/CY7C1367C supports secondary cache in systems utilizing either a linear or interleaved burst sequence. The interleaved burst order supports Pentium and i486™ processors. The linear burst sequence is suited for processors that utilize a linear burst sequence. The burst order is user selectable, and is determined by sampling the MODE input. Accesses can be initiated with either the Processor Address Strobe (ADSP) or the Controller Address Strobe (ADSC). Address advancement through the burst sequence is controlled by the ADV input. A two-bit on-chip wraparound burst counter captures the first address in a burst sequence and automatically increments the address for the rest of the burst access.

Byte write operations are qualified with the Byte Write Enable (BWE) and Byte Write Select (BW_X) inputs. A Global Write Enable (GW) overrides all byte write inputs and writes data to all four bytes. All writes are simplified with on-chip synchronous self-timed write circuitry.

Synchronous Chip Selects \overline{CE}_1 , CE₂, \overline{CE}_3 ^[2] and an asynchronous Output Enable (OE) provide for easy bank selection and output tri-state control. ADSP is ignored if \overline{CE}_1 is HIGH.

Single Read Accesses

This access is initiated when the following conditions are satisfied at clock rise: (1) ADSP or ADSC is asserted LOW, (2) chip selects are all asserted active, and (3) the write signals (GW, BWE) are all deasserted HIGH. ADSP is ignored if \overline{CE}_1 is HIGH. The address presented to the address inputs is stored into the address advancement logic and the Address Register while being presented to the memory core. The corresponding data is allowed to propagate to the input of the Output Registers. At the rising edge of the next clock the data is allowed to propagate through the output register and onto the data bus within t_{co} if OE is active LOW. The only exception occurs when the SRAM is emerging from a deselected state to a selected state, its outputs are always tri-stated during the first cycle of the access. After the first cycle of the access, the

outputs are controlled by the \overline{OE} signal. Consecutive single read cycles are supported.

The CY7C1366C/CY7C1367C is a double-cycle deselect part. Once the SRAM is deselected at clock rise by the chip select and either ADSP or ADSC signals, its output will tri-state immediately after the next clock rise.

Single Write Accesses Initiated by ADSP

This access is initiated when both of the following conditions are satisfied at clock rise: (1) ADSP is asserted LOW, and (2) chip select is asserted active. The address presented is loaded into the address register and the address advancement logic while being delivered to the memory core. The write signals (GW, BWE, and BW_X) and ADV inputs are ignored during this first cycle.

\overline{ADSP} triggered write accesses require two clock cycles to complete. If GW is asserted LOW on the second clock rise, the data presented to the DQ_X inputs is written into the corresponding address location in the memory core. If GW is HIGH, then the write operation is controlled by BWE and BW_X signals. The CY7C1366C/CY7C1367C provides byte write capability that is described in the Write Cycle Description table. Asserting the Byte Write Enable input (BWE) with the selected Byte Write input will selectively write to only the desired bytes. Bytes not selected during a byte write operation will remain unaltered. A synchronous self-timed write mechanism has been provided to simplify the write operations.

Because the CY7C1366C/CY7C1367C is a common I/O device, the Output Enable (\overline{OE}) must be deasserted HIGH before presenting data to the DQ inputs. Doing so will tri-state the output drivers. As a safety precaution, DQ are automatically tri-stated whenever a write cycle is detected, regardless of the state of \overline{OE} .

Single Write Accesses Initiated by ADSC

ADSC write accesses are initiated when the following conditions are satisfied: (1) ADSC is asserted LOW, (2) ADSP is deasserted HIGH, (3) chip select is asserted active, and (4) the appropriate combination of the write inputs (GW, BWE, and BW_X) are asserted active to conduct a write to the desired byte(s). ADSC triggered write accesses require a single clock cycle to complete. The address presented is loaded into the address register and the address advancement logic while being delivered to the memory core. The ADV input is ignored

during this cycle. If a global write is conducted, the data presented to the DQ_X is written into the corresponding address location in the memory core. If a byte write is conducted, only the selected bytes are written. Bytes not selected during a byte write operation will remain unaltered. A synchronous self-timed write mechanism has been provided to simplify the write operations.

Because the CY7C1366C/CY7C1367C is a common I/O device, the Output Enable (\overline{OE}) must be deasserted HIGH before presenting data to the DQ_X inputs. Doing so will tri-state the output drivers. As a safety precaution, DQ_X are automatically tri-stated whenever a write cycle is detected, regardless of the state of OE.

Burst Sequences

The CY7C1366C/CY7C1367C provides a two-bit wraparound counter, fed by $A_{[1:0]}$, that implements either an interleaved or linear burst sequence. The interleaved burst sequence is designed specifically to support Intel Pentium applications. The linear burst sequence is designed to support processors that follow a linear burst sequence. The burst sequence is user selectable through the MODE input. Both read and write burst operations are supported.

Asserting \overline{ADV} LOW at clock rise will automatically increment the burst counter to the next address in the burst sequence. Both read and write burst operations are supported.

Sleep Mode

The ZZ input pin is an asynchronous input. Asserting ZZ places the SRAM in a power conservation “sleep” mode. Two

clock cycles are required to enter into or exit from this “sleep” mode. While in this mode, data integrity is guaranteed. Accesses pending when entering the “sleep” mode are not considered valid nor is the completion of the operation guaranteed. The device must be deselected prior to entering the “sleep” mode. CEs, ADSP, and ADSC must remain inactive for the duration of t_{ZZREC} after the ZZ input returns LOW.

**Interleaved Burst Address Table
(MODE = Floating or V_{DD})**

First Address A1: A0	Second Address A1: A0	Third Address A1: A0	Fourth Address A1: A0
00	01	10	11
01	00	11	10
10	11	00	01
11	10	01	00

Linear Burst Address Table (MODE = GND)

First Address A1: A0	Second Address A1: A0	Third Address A1: A0	Fourth Address A1: A0
00	01	10	11
01	10	11	00
10	11	00	01
11	00	01	10

ZZ Mode Electrical Characteristics

Parameter	Description	Test Conditions	Min.	Max.	Unit
I_{DDZZ}	Sleep mode standby current	$ZZ \geq V_{DD} - 0.2V$		50	mA
t_{ZZS}	Device operation to ZZ	$ZZ \geq V_{DD} - 0.2V$		$2t_{CYC}$	ns
t_{ZZREC}	ZZ recovery time	$ZZ \leq 0.2V$	$2t_{CYC}$		ns
t_{ZZI}	ZZ active to sleep current	This parameter is sampled		$2t_{CYC}$	ns
t_{RZZI}	ZZ Inactive to exit sleep current	This parameter is sampled	0		ns

Partial Truth Table for Read/Write^[5, 10]

Function (CY7C1366C)	\overline{GW}	\overline{BWE}	$\overline{BW_D}$	$\overline{BW_C}$	$\overline{BW_B}$	$\overline{BW_A}$
Read	H	H	X	X	X	X
Read	H	L	H	H	H	H
Write Byte A – (DQ _A and DQP _A)	H	L	H	H	H	L
Write Byte B – (DQ _B and DQP _B)	H	L	H	H	L	H
Write Bytes B, A	H	L	H	H	L	L
Write Byte C – (DQ _C and DQP _C)	H	L	H	L	H	H
Write Bytes C, A	H	L	H	L	H	L
Write Bytes C, B	H	L	H	L	L	H
Write Bytes C, B, A	H	L	H	L	L	L
Write Byte D – (DQ _D and DQP _D)	H	L	L	H	H	H
Write Bytes D, A	H	L	L	H	H	L
Write Bytes D, B	H	L	L	H	L	H
Write Bytes D, B, A	H	L	L	H	L	L
Write Bytes D, C	H	L	L	L	H	H
Write Bytes D, C, A	H	L	L	L	H	L
Write Bytes D, C, B	H	L	L	L	L	H
Write All Bytes	H	L	L	L	L	L
Write All Bytes	L	X	X	X	X	X

Truth Table for Read/Write^[5, 10]

Function (CY7C1367C)	\overline{GW}	\overline{BWE}	$\overline{BW_B}$	$\overline{BW_A}$
Read	H	H	X	X
Read	H	L	H	H
Write Byte A – (DQ _A and DQP _A)	H	L	H	L
Write Byte B – (DQ _B and DQP _B)	H	L	L	H
Write All Bytes	H	L	L	L
Write All Bytes	L	X	X	X

IEEE 1149.1 Serial Boundary Scan (JTAG)

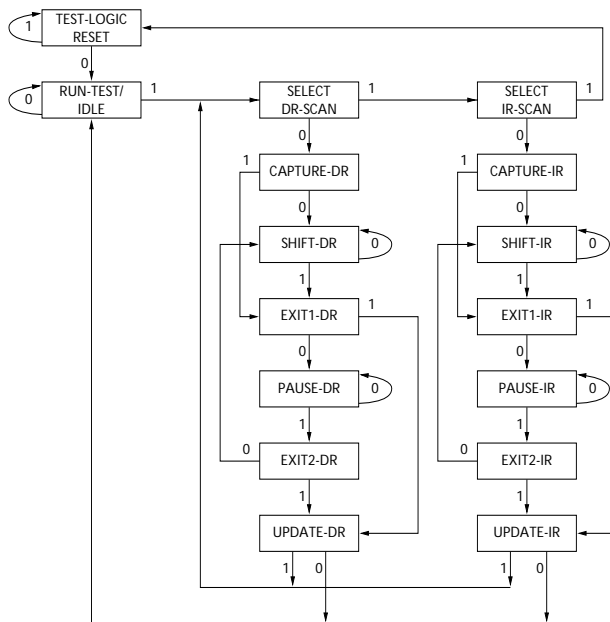
The CY7C1366C/CY7C1367C incorporates a serial boundary scan test access port (TAP) in the BGA package only. The TQFP package does not offer this functionality. This part operates in accordance with IEEE Standard 1149.1-1900, but doesn't have the set of functions required for full 1149.1 compliance. These functions from the IEEE specification are excluded because their inclusion places an added delay in the critical speed path of the SRAM. Note the TAP controller functions in a manner that does not conflict with the operation of other devices using 1149.1 fully compliant TAPs. The TAP operates using JEDEC-standard 3.3V or 2.5V I/O logic levels.

The CY7C1366C/CY7C1367C contains a TAP controller, instruction register, boundary scan register, bypass register, and ID register.

Disabling the JTAG Feature

It is possible to operate the SRAM without using the JTAG feature. To disable the TAP controller, TCK must be tied LOW (V_{SS}) to prevent clocking of the device. TDI and TMS are internally pulled up and may be unconnected. They may alternately be connected to V_{DD} through a pull-up resistor. TDO should be left unconnected. Upon power-up, the device will come up in a reset state which will not interfere with the operation of the device.

TAP Controller State Diagram



The 0/1 next to each state represents the value of TMS at the rising edge of TCK.

Test Access Port (TAP)

Test Clock (TCK)

The test clock is used only with the TAP controller. All inputs are captured on the rising edge of TCK. All outputs are driven from the falling edge of TCK.

Test MODE SELECT (TMS)

The TMS input is used to give commands to the TAP controller and is sampled on the rising edge of TCK. It is allowable to leave this ball unconnected if the TAP is not used. The ball is pulled up internally, resulting in a logic HIGH level.

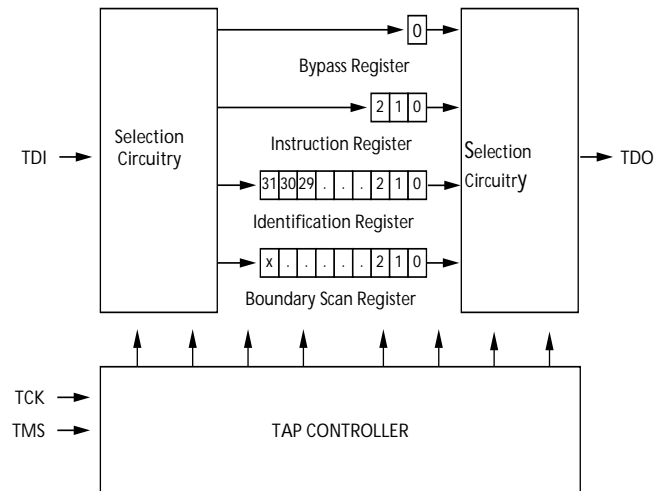
Test Data-In (TDI)

The TDI ball is used to serially input information into the registers and can be connected to the input of any of the registers. The register between TDI and TDO is chosen by the instruction that is loaded into the TAP instruction register. TDI is internally pulled up and can be unconnected if the TAP is unused in an application. TDI is connected to the most significant bit (MSB) of any register. (See Tap Controller Block Diagram.)

Test Data-Out (TDO)

The TDO output ball is used to serially clock data-out from the registers. The output is active depending upon the current state of the TAP state machine. The output changes on the falling edge of TCK. TDO is connected to the least significant bit (LSB) of any register. (See Tap Controller State Diagram.)

TAP Controller Block Diagram



Performing a TAP Reset

A RESET is performed by forcing TMS HIGH (V_{DD}) for five rising edges of TCK. This RESET does not affect the operation of the SRAM and may be performed while the SRAM is operating.

At power-up, the TAP is reset internally to ensure that TDO comes up in a High-Z state.

TAP Registers

Registers are connected between the TDI and TDO balls and allow data to be scanned into and out of the SRAM test circuitry. Only one register can be selected at a time through the instruction register. Data is serially loaded into the TDI ball on the rising edge of TCK. Data is output on the TDO ball on the falling edge of TCK.

Instruction Register

Three-bit instructions can be serially loaded into the instruction register. This register is loaded when it is placed between the

TDI and TDO balls as shown in the Tap Controller Block Diagram. Upon power-up, the instruction register is loaded with the IDCODE instruction. It is also loaded with the IDCODE instruction if the controller is placed in a reset state as described in the previous section.

When the TAP controller is in the Capture-IR state, the two least significant bits are loaded with a binary "01" pattern to allow for fault isolation of the board-level serial test data path.

Bypass Register

To save time when serially shifting data through registers, it is sometimes advantageous to skip certain chips. The bypass register is a single-bit register that can be placed between the TDI and TDO balls. This allows data to be shifted through the SRAM with minimal delay. The bypass register is set LOW (V_{SS}) when the BYPASS instruction is executed.

Boundary Scan Register

The boundary scan register is connected to all the input and bidirectional balls on the SRAM.

The boundary scan register is loaded with the contents of the RAM I/O ring when the TAP controller is in the Capture-DR state and is then placed between the TDI and TDO balls when the controller is moved to the Shift-DR state. The EXTEST, SAMPLE/PRELOAD and SAMPLE Z instructions can be used to capture the contents of the I/O ring.

The Boundary Scan Order tables show the order in which the bits are connected. Each bit corresponds to one of the bumps on the SRAM package. The MSB of the register is connected to TDI and the LSB is connected to TDO.

Identification (ID) Register

The ID register is loaded with a vendor-specific, 32-bit code during the Capture-DR state when the IDCODE command is loaded in the instruction register. The IDCODE is hardwired into the SRAM and can be shifted out when the TAP controller is in the Shift-DR state. The ID register has a vendor code and other information described in the Identification Register Definitions table.

TAP Instruction Set

Overview

Eight different instructions are possible with the three-bit instruction register. All combinations are listed in the Instruction Codes table. Three of these instructions are listed as RESERVED and should not be used. The other five instructions are described in detail below.

The TAP controller used in this SRAM is not fully compliant to the 1149.1 convention because some of the mandatory 1149.1 instructions are not fully implemented.

The TAP controller cannot be used to load address data or control signals into the SRAM and cannot preload the I/O buffers. The SRAM does not implement the 1149.1 commands EXTEST or INTEST or the PRELOAD portion of SAMPLE/PRELOAD; rather, it performs a capture of the I/O ring when these instructions are executed.

Instructions are loaded into the TAP controller during the Shift-IR state when the instruction register is placed between TDI and TDO. During this state, instructions are shifted

through the instruction register through the TDI and TDO balls. To execute the instruction once it is shifted in, the TAP controller needs to be moved into the Update-IR state.

EXTEST

EXTEST is a mandatory 1149.1 instruction which is to be executed whenever the instruction register is loaded with all 0s. EXTEST is not implemented in this SRAM TAP controller, and therefore this device is not compliant to 1149.1. The TAP controller does not recognize an all-0 instruction.

When an EXTEST instruction is loaded into the instruction register, the SRAM responds as if a SAMPLE/PRELOAD instruction has been loaded. There is one difference between the two instructions. Unlike the SAMPLE/PRELOAD instruction, EXTEST places the SRAM outputs in a High-Z state.

IDCODE

The IDCODE instruction causes a vendor-specific, 32-bit code to be loaded into the instruction register. It also places the instruction register between the TDI and TDO balls and allows the IDCODE to be shifted out of the device when the TAP controller enters the Shift-DR state.

The IDCODE instruction is loaded into the instruction register upon power-up or whenever the TAP controller is given a test logic reset state.

SAMPLE Z

The SAMPLE Z instruction causes the boundary scan register to be connected between the TDI and TDO balls when the TAP controller is in a Shift-DR state. It also places all SRAM outputs into a High-Z state.

SAMPLE/PRELOAD

SAMPLE/PRELOAD is a 1149.1 mandatory instruction. When the SAMPLE/PRELOAD instructions are loaded into the instruction register and the TAP controller is in the Capture-DR state, a snapshot of data on the inputs and output pins is captured in the boundary scan register.

The user must be aware that the TAP controller clock can only operate at a frequency up to 20 MHz, while the SRAM clock operates more than an order of magnitude faster. Because there is a large difference in the clock frequencies, it is possible that during the Capture-DR state, an input or output will undergo a transition. The TAP may then try to capture a signal while in transition (metastable state). This will not harm the device, but there is no guarantee as to the value that will be captured. Repeatable results may not be possible.

To guarantee that the boundary scan register will capture the correct value of a signal, the SRAM signal must be stabilized long enough to meet the TAP controller's capture set-up plus hold times (t_{CS} and t_{CH}). The SRAM clock input might not be captured correctly if there is no way in a design to stop (or slow) the clock during a SAMPLE/PRELOAD instruction. If this is an issue, it is still possible to capture all other signals and simply ignore the value of the CK and CK# captured in the boundary scan register.

Once the data is captured, it is possible to shift out the data by putting the TAP into the Shift-DR state. This places the boundary scan register between the TDI and TDO pins.

PRELOAD allows an initial data pattern to be placed at the latched parallel outputs of the boundary scan register cells prior to the selection of another boundary scan test operation. The shifting of data for the SAMPLE and PRELOAD phases can occur concurrently when required—that is, while data captured is shifted out, the preloaded data can be shifted in.

BYPASS

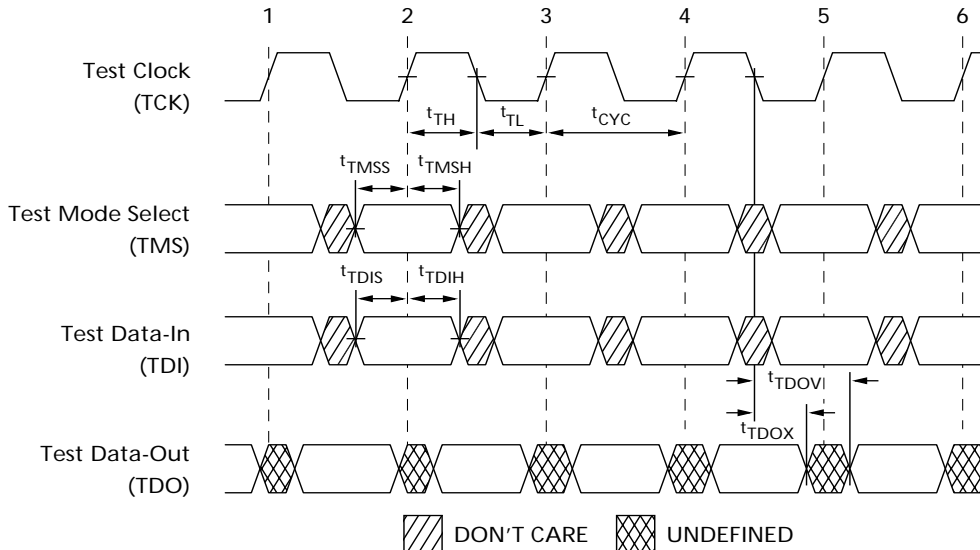
When the BYPASS instruction is loaded in the instruction register and the TAP is placed in a Shift-DR state, the bypass

register is placed between the TDI and TDO balls. The advantage of the BYPASS instruction is that it shortens the boundary scan path when multiple devices are connected together on a board.

Reserved

These instructions are not implemented but are reserved for future use. Do not use these instructions.

TAP Timing



TAP AC Switching Characteristics Over the Operating Range^[3, 4]

Parameter	Description	Min.	Max.	Unit
Clock				
t _{TCYC}	TCK Clock Cycle Time	50		ns
t _{TF}	TCK Clock Frequency		20	MHz
t _{TH}	TCK Clock HIGH Time	20		ns
t _{TL}	TCK Clock LOW Time	20		ns
Output Times				
t _{TDOV}	TCK Clock LOW to TDO Valid		10	ns
t _{TDOX}	TCK Clock LOW to TDO Invalid	0		ns
Set-up Times				
t _{TMSS}	TMS Set-up to TCK Clock Rise	5		ns
t _{TDIS}	TDI Set-up to TCK Clock Rise	5		ns
t _{CS}	Capture Set-up to TCK Rise	5		ns
Hold Times				
t _{TMSH}	TMS Hold after TCK Clock Rise	5		ns
t _{TDIH}	TDI Hold after Clock Rise	5		ns
t _{CH}	Capture Hold after Clock Rise	5		ns

Notes:

- 3. t_{CS} and t_{CH} refer to the set-up and hold time requirements of latching data from the boundary scan register.
- 4. Test conditions are specified using the load in TAP AC test Conditions. t_r/t_f = 1 ns.

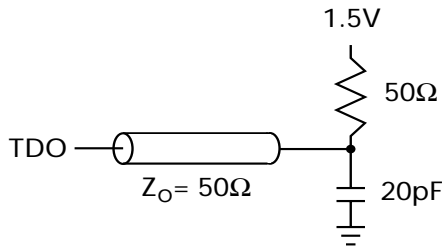
3.3V TAP AC Test Conditions

Input pulse levels V_{SS} to 3.3V
 Input rise and fall times 1 ns
 Input timing reference levels 1.5V
 Output reference levels 1.5V
 Test load termination supply voltage 1.5V

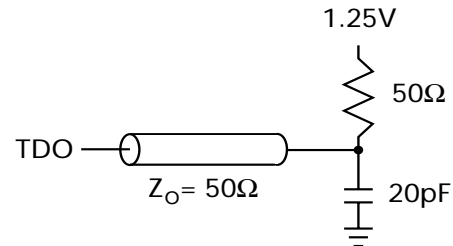
2.5V TAP AC Test Conditions

Input pulse levels V_{SS} to 2.5V
 Input rise and fall time 1 ns
 Input timing reference levels 1.25V
 Output reference levels 1.25V
 Test load termination supply voltage 1.25V

3.3V TAP AC Output Load Equivalent



2.5V TAP AC Output Load Equivalent



TAP DC Electrical Characteristics And Operating Conditions

($0^{\circ}\text{C} < T_A < +70^{\circ}\text{C}$; $V_{DD} = 3.3\text{V} \pm 0.165\text{V}$ unless otherwise noted)^[5]

Parameter	Description	Conditions		Min.	Max.	Unit
V_{OH1}	Output HIGH Voltage	$I_{OH} = -4.0\text{ mA}$	$V_{DDQ} = 3.3\text{V}$	2.4		V
		$I_{OH} = -1.0\text{ mA}$	$V_{DDQ} = 2.5\text{V}$	2.0		V
V_{OH2}	Output HIGH Voltage	$I_{OH} = -100\text{ }\mu\text{A}$	$V_{DDQ} = 3.3\text{V}$	2.9		V
			$V_{DDQ} = 2.5\text{V}$	2.1		V
V_{OL1}	Output LOW Voltage	$I_{OL} = 8.0\text{ mA}$	$V_{DDQ} = 3.3\text{V}$		0.4	V
		$I_{OL} = 8.0\text{ mA}$	$V_{DDQ} = 2.5\text{V}$		0.4	V
V_{OL2}	Output LOW Voltage	$I_{OL} = 100\text{ }\mu\text{A}$	$V_{DDQ} = 3.3\text{V}$		0.2	V
			$V_{DDQ} = 2.5\text{V}$		0.2	V
V_{IH}	Input HIGH Voltage		$V_{DDQ} = 3.3\text{V}$	2.0	$V_{DD} + 0.3$	V
			$V_{DDQ} = 2.5\text{V}$	1.7	$V_{DD} + 0.3$	V
V_{IL}	Input LOW Voltage		$V_{DDQ} = 3.3\text{V}$	-0.5	0.7	V
			$V_{DDQ} = 2.5\text{V}$	-0.3	0.7	V
I_X	Input Load Current	$\text{GND} \leq V_{IN} \leq V_{DDQ}$		-5	5	μA

Identification Register Definitions

Instruction Field	CY7C1366C (256K x36)	CY7C1367C (512K x18)	Description
Revision Number (31:29)	000	000	Describes the version number.
Device Depth (28:24) ^[6]	01011	01011	Reserved for Internal Use
Device Width (23:18) 119-BGA	101110	101110	Defines memory type and architecture
Device Width (23:18) 165-FBGA	000110	000110	Defines memory type and architecture
Cypress Device ID (17:12)	100110	010110	Defines width and density
Cypress JEDEC ID Code (11:1)	00000110100	00000110100	Allows unique identification of SRAM vendor.
ID Register Presence Indicator (0)	1	1	Indicates the presence of an ID register.

Notes:

- All voltages referenced to V_{SS} (GND).
- Bit #24 is "1" in the Register Definitions for both 2.5V and 3.3V versions of this device.

Scan Register Sizes

Register Name	Bit Size (x36)	Bit Size (x18)
Instruction	3	3
Bypass	1	1
ID	32	32
Boundary Scan Order (119-ball BGA package)	71	71
Boundary Scan Order (165-ball FBGA package)	71	71

Identification Codes

Instruction	Code	Description
EXTEST	000	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM outputs to High-Z state.
IDCODE	001	Loads the ID register with the vendor ID code and places the register between TDI and TDO. This operation does not affect SRAM operations.
SAMPLE Z	010	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Forces all SRAM output drivers to a High-Z state.
RESERVED	011	Do Not Use: This instruction is reserved for future use.
SAMPLE/PRELOAD	100	Captures I/O ring contents. Places the boundary scan register between TDI and TDO. Does not affect SRAM operation.
RESERVED	101	Do Not Use: This instruction is reserved for future use.
RESERVED	110	Do Not Use: This instruction is reserved for future use.
BYPASS	111	Places the bypass register between TDI and TDO. This operation does not affect SRAM operations.

119-Ball BGA Boundary Scan Order

CY7C1366C (256K x 36)					
Bit #	ball ID	Signal Name	Bit #	ball ID	Signal Name
1	K4	CLK	37	P4	A0
2	H4	\overline{GW}	38	N4	A1
3	M4	\overline{BWE}	39	R6	A
4	F4	\overline{OE}	40	T5	A
5	B4	\overline{ADSC}	41	T3	A
6	A4	\overline{ADSP}	42	R2	A
7	G4	\overline{ADV}	43	R3	MODE
8	C3	A	44	P2	DQP _D
9	B3	A	45	P1	DQ _D
10	D6	DQP _B	46	L2	DQ _D
11	H7	DQ _B	47	K1	DQ _D
12	G6	DQ _B	48	N2	DQ _D
13	E6	DQ _B	49	N1	DQ _D
14	D7	DQ _B	50	M2	DQ _D
15	E7	DQ _B	51	L1	DQ _D
16	F6	DQ _B	52	K2	DQ _D
17	G7	DQ _B	53	Internal	Internal
18	H6	DQ _B	54	H1	DQ _C
19	T7	ZZ	55	G2	DQ _C
20	K7	DQ _A	56	E2	DQ _C
21	L6	DQ _A	57	D1	DQ _C
22	N6	DQ _A	58	H2	DQ _C
23	P7	DQ _A	59	G1	DQ _C
24	N7	DQ _A	60	F2	DQ _C
25	M6	DQ _A	61	E1	DQ _C
26	L7	DQ _A	62	D2	DQP _C
27	K6	DQ _A	63	C2	A
28	P6	DQP _A	64	A2	A
29	T4	A	65	E4	\overline{CE}_1
30	A3	A	66	B2	\overline{CE}_2
31	C5	A	67	L3	\overline{BWD}
32	B5	A	68	G3	\overline{BW}_C
33	A5	A	69	G5	\overline{BW}_B
34	C6	A	70	L5	\overline{BW}_A
35	A6	A	71	Internal	Internal
36	B6	A			

CY7C1367C (512K x 18)					
Bit #	ball ID	Signal Name	Bit #	ball ID	Signal Name
1	K4	CLK	37	P4	A0
2	H4	\overline{GW}	38	N4	A1
3	M4	\overline{BWE}	39	R6	A
4	F4	\overline{OE}	40	T5	A
5	B4	\overline{ADSC}	41	T3	A
6	A4	\overline{ADSP}	42	R2	A
7	G4	\overline{ADV}	43	R3	MODE
8	C3	A	44	Internal	Internal
9	B3	A	45	Internal	Internal
10	T2	A	46	Internal	Internal
11	Internal	Internal	47	Internal	Internal
12	Internal	Internal	48	P2	DQP _B
13	Internal	Internal	49	N1	DQ _B
14	D6	DQP _A	50	M2	DQ _B
15	E7	DQ _A	51	L1	DQ _B
16	F6	DQ _A	52	K2	DQ _B
17	G7	DQ _A	53	Internal	Internal
18	H6	DQ _A	54	H1	DQ _B
19	T7	ZZ	55	G2	DQ _B
20	K7	DQ _A	56	E2	DQ _B
21	L6	DQ _A	57	D1	DQ _B
22	N6	DQ _A	58	Internal	Internal
23	P7	DQ _A	59	Internal	Internal
24	Internal	Internal	60	Internal	Internal
25	Internal	Internal	61	Internal	Internal
26	Internal	Internal	62	Internal	Internal
27	Internal	Internal	63	C2	A
28	Internal	Internal	64	A2	A
29	T6	A	65	E4	\overline{CE}_1
30	A3	A	66	B2	\overline{CE}_2
31	C5	A	67	Internal	Internal
32	B5	A	68	Internal	Internal
33	A5	A	69	G3	\overline{BW}_B
34	C6	A	70	L5	\overline{BW}_A
35	A6	A	71	Internal	Internal
36	B6	A			

165-Ball FBGA Boundary Scan Order

CY7C1366C (256K x 36)					
Bit #	ball ID	Signal Name	Bit #	ball ID	Signal Name
1	B6	CLK	37	R6	A0
2	B7	GW	38	P6	A1
3	A7	BWE	39	R4	A
4	B8	OE	40	P4	A
5	A8	ADSC	41	R3	A
6	B9	ADSP	42	P3	A
7	A9	ADV	43	R1	MODE
8	B10	A	44	N1	DQP _D
9	A10	A	45	L2	DQ _D
10	C11	DQP _B	46	K2	DQ _D
11	E10	DQ _B	47	J2	DQ _D
12	F10	DQ _B	48	M2	DQ _D
13	G10	DQ _B	49	M1	DQ _D
14	D10	DQ _B	50	L1	DQ _D
15	D11	DQ _B	51	K1	DQ _D
16	E11	DQ _B	52	J1	DQ _D
17	F11	DQ _B	53	Internal	Internal
18	G11	DQ _B	54	G2	DQ _C
19	H11	ZZ	55	F2	DQ _C
20	J10	DQ _A	56	E2	DQ _C
21	K10	DQ _A	57	D2	DQ _C
22	L10	DQ _A	58	G1	DQ _C
23	M10	DQ _A	59	F1	DQ _C
24	J11	DQ _A	60	E1	DQ _C
25	K11	DQ _A	61	D1	DQ _C
26	L11	DQ _A	62	C1	DQP _C
27	M11	DQ _A	63	B2	A
28	N11	DQP _A	64	A2	A
29	R11	A	65	A3	CE ₁
30	R10	A	66	B3	CE ₂
31	P10	A	67	B4	BW _D
32	R9	A	68	A4	BW _C
33	P9	A	69	A5	BW _B
34	R8	A	70	B5	BW _A
35	P8	A	71	A6	CE ₃
36	P11	A			

CY7C1367C (512K x 18)					
Bit #	ball ID	Signal Name	Bit #	ball ID	Signal Name
1	B6	CLK	37	R6	A0
2	B7	GW	38	P6	A1
3	A7	BWE	39	R4	A
4	B8	OE	40	P4	A
5	A8	ADSC	41	R3	A
6	B9	ADSP	42	P3	A
7	A9	ADV	43	R1	MODE
8	B10	A	44	Internal	Internal
9	A10	A	45	Internal	Internal
10	A11	A	46	Internal	Internal
11	Internal	Internal	47	Internal	Internal
12	Internal	Internal	48	N1	DQP _B
13	Internal	Internal	49	M1	DQ _B
14	C11	DQP _A	50	L1	DQ _B
15	D11	DQ _A	51	K1	DQ _B
16	E11	DQ _A	52	J1	DQ _B
17	F11	DQ _A	53	Internal	Internal
18	G11	DQ _A	54	G2	DQ _B
19	H11	ZZ	55	F2	DQ _B
20	J10	DQ _A	56	E2	DQ _B
21	K10	DQ _A	57	D2	DQ _B
22	L10	DQ _A	58	Internal	Internal
23	M10	DQ _A	59	Internal	Internal
24	Internal	Internal	60	Internal	Internal
25	Internal	Internal	61	Internal	Internal
26	Internal	Internal	62	Internal	Internal
27	Internal	Internal	63	B2	A
28	Internal	Internal	64	A2	A
29	R11	A	65	A3	CE ₁
30	R10	A	66	B3	CE ₂
31	P10	A	67	Internal	Internal
32	R9	A	68	Internal	Internal
33	P9	A	69	A4	BW _B
34	R8	A	70	B5	BW _A
35	P8	A	71	A6	CE ₃
36	P11	A			

Maximum Ratings

(Above which the useful life may be impaired. For user guidelines, not tested.)

- Storage Temperature -65°C to +150°C
- Ambient Temperature with Power Applied..... -55°C to +125°C
- Supply Voltage on V_{DD} Relative to GND..... -0.5V to +4.6V
- Supply Voltage on V_{DDQ} Relative to GND -0.5V to +V_{DD}
- DC Voltage Applied to Outputs in tri-state -0.5V to V_{DDQ} + 0.5V

- DC Input Voltage -0.5V to V_{DD} + 0.5V
- Current into Outputs (LOW)..... 20 mA
- Static Discharge Voltage..... > 2001V (per MIL-STD-883, Method 3015)
- Latch-up Current..... > 200 mA

Operating Range

Range	Ambient Temperature	V _{DD}	V _{DDQ}
Commercial	0°C to +70°C	3.3V - 5%/+10%	2.5V - 5% to V _{DD}
Industrial	-40°C to +85°C		

Electrical Characteristics Over the Operating Range [7, 8]

Parameter	Description	Test Conditions	Min.	Max.	Unit
V _{DD}	Power Supply Voltage		3.135	3.6	V
V _{DDQ}	I/O Supply Voltage	for 3.3V I/O	3.135	V _{DD}	V
		for 2.5V I/O	2.375	2.625	V
V _{OH}	Output HIGH Voltage	for 3.3V I/O, I _{OH} = -4.0 mA	2.4		V
		for 2.5V I/O, I _{OH} = -1.0 mA	2.0		V
V _{OL}	Output LOW Voltage	for 3.3V I/O, I _{OL} = 8.0 mA		0.4	V
		for 2.5V I/O, I _{OL} = 1.0 mA		0.4	V
V _{IH}	Input HIGH Voltage ^[7]	for 3.3V I/O	2.0	V _{DD} + 0.3V	V
		for 2.5V I/O	1.7	V _{DD} + 0.3V	V
V _{IL}	Input LOW Voltage ^[7]	for 3.3V I/O	-0.3	0.8	V
		for 2.5V I/O	-0.3	0.7	V
I _X	Input Leakage Current except ZZ and MODE	GND ≤ V _I ≤ V _{DDQ}	-5	5	μA
	Input Current of MODE	Input = V _{SS}	-30		μA
		Input = V _{DD}		5	μA
	Input Current of ZZ	Input = V _{SS}	-5		μA
Input = V _{DD}			30	μA	
I _{OZ}	Output Leakage Current	GND ≤ V _I ≤ V _{DDQ} , Output Disabled	-5	5	μA
I _{DD}	V _{DD} Operating Supply Current	V _{DD} = Max., I _{OUT} = 0 mA, f = f _{MAX} = 1/t _{CYC}	4-ns cycle, 250 MHz	250	mA
			5-ns cycle, 200 MHz	220	mA
			6-ns cycle, 166 MHz	180	mA
I _{SB1}	Automatic CE Power-down Current—TTL Inputs	V _{DD} = Max, Device Deselected, V _{IN} ≥ V _{IH} or V _{IN} ≤ V _{IL} , f = f _{MAX} = 1/t _{CYC}	4-ns cycle, 250 MHz	130	mA
			5-ns cycle, 200 MHz	120	mA
			6-ns cycle, 166 MHz	110	mA
I _{SB2}	Automatic CE Power-down Current—CMOS Inputs	V _{DD} = Max, Device Deselected, V _{IN} ≤ 0.3V or V _{IN} ≥ V _{DDQ} - 0.3V, f = 0	All speeds	40	mA
I _{SB3}	Automatic CE Power-down Current—CMOS Inputs	V _{DD} = Max, Device Deselected, or V _{IN} ≤ 0.3V or V _{IN} ≥ V _{DDQ} - 0.3V, f = f _{MAX} = 1/t _{CYC}	4-ns cycle, 250 MHz	120	mA
			5-ns cycle, 200 MHz	110	mA
			6-ns cycle, 166 MHz	100	mA
I _{SB4}	Automatic CE Power-down Current—TTL Inputs	V _{DD} = Max, Device Deselected, V _{IN} ≥ V _{IH} or V _{IN} ≤ V _{IL} , f = 0	All Speeds	40	mA

Notes:

- 7. Overshoot: V_{IH}(AC) < V_{DD} + 1.5V (Pulse width less than t_{CYC}/2), undershoot: V_{IL}(AC) > -2V (Pulse width less than t_{CYC}/2).
- 8. TPower-up: Assumes a linear ramp from 0V to V_{DD}(min.) within 200 ms. During this time V_{IH} < V_{DD} and V_{DDQ} ≤ V_{DD}.

Capacitance^[9]

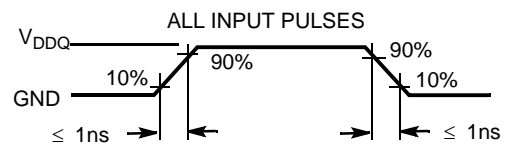
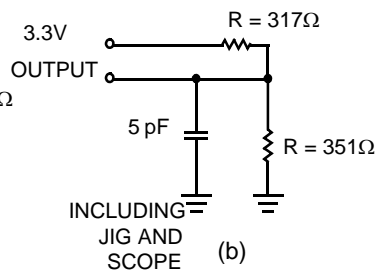
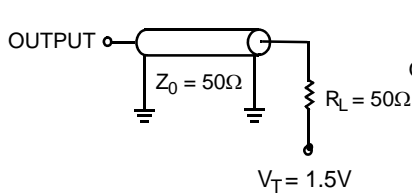
Parameter	Description	Test Conditions	100 TQFP Max.	119 BGA Max.	165 FBGA Max.	Unit
C_{IN}	Input Capacitance	$T_A = 25^\circ\text{C}$, $f = 1\text{ MHz}$, $V_{DD} = 3.3\text{V}$, $V_{DDQ} = 2.5\text{V}$	5	5	5	pF
C_{CLK}	Clock Input Capacitance		5	5	5	pF
$C_{I/O}$	Input/Output Capacitance		5	7	7	pF

Thermal Resistance^[9]

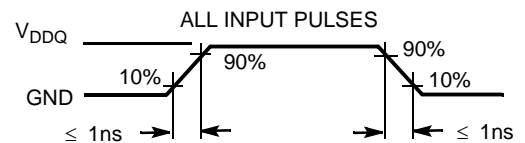
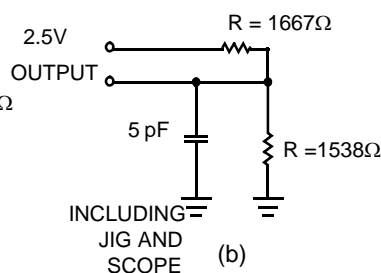
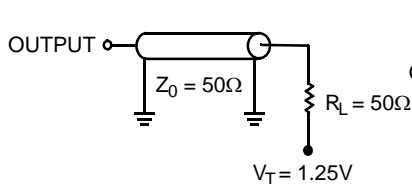
Parameter	Description	Test Conditions	100 TQFP Package	119 BGA Package	165 FBGA Package	Unit
Θ_{JA}	Thermal Resistance (Junction to Ambient)	Test conditions follow standard test methods and procedures for measuring thermal impedance, per EIA/JESD51.	29.41	34.1	16.8	$^\circ\text{C/W}$
Θ_{JC}	Thermal Resistance (Junction to Case)		6.31	14.0	3.0	$^\circ\text{C/W}$

AC Test Loads and Waveforms

3.3V I/O Test Load



2.5V I/O Test Load



Note:

9. Tested initially and after any design or process change that may affect these parameters.

Switching Characteristics Over the Operating Range^[14, 15]

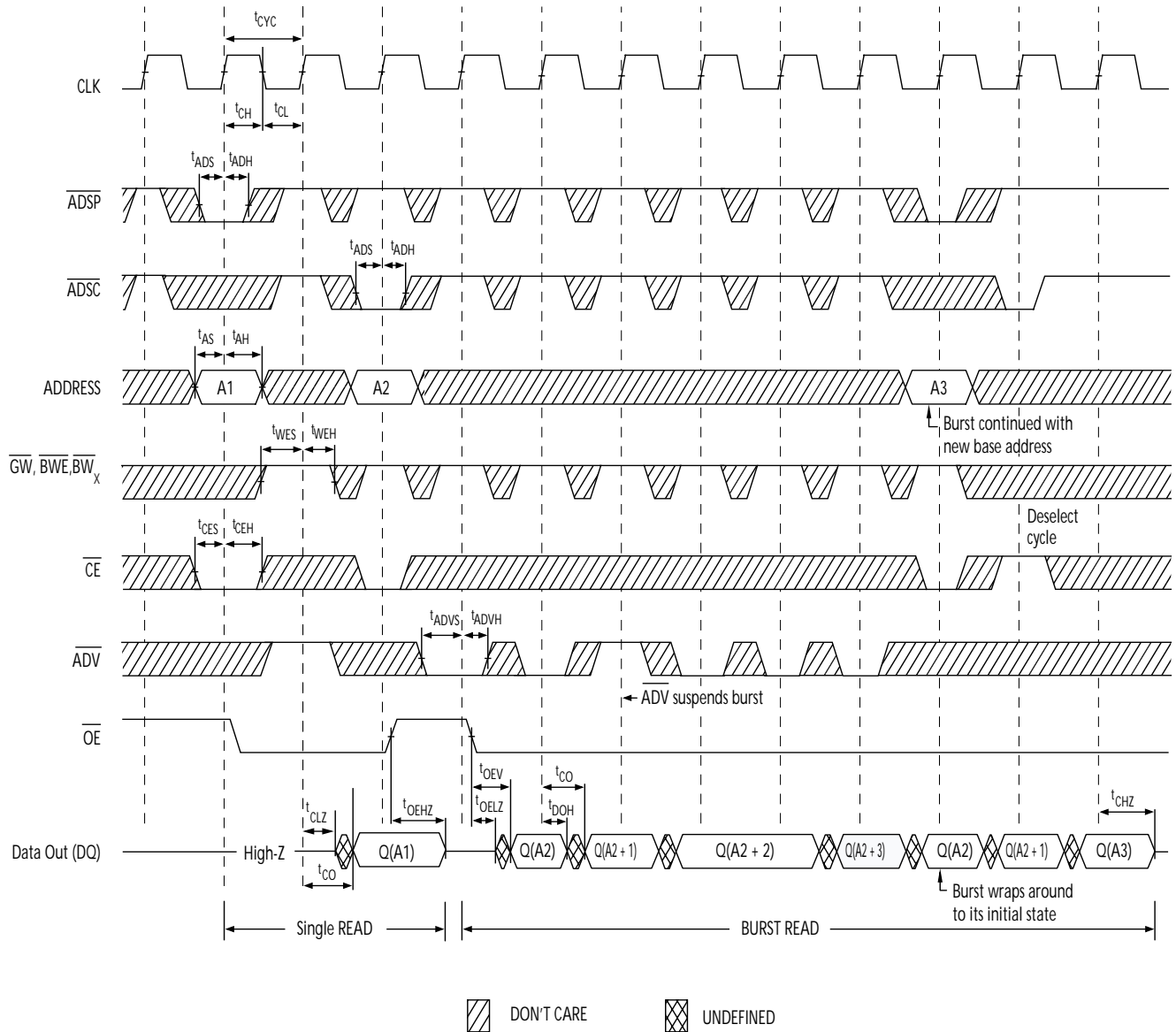
Parameter	Description	-250		-200		166 MHz		Unit
		Min.	Max.	Min.	Max.	Min.	Max.	
t _{POWER}	V _{DD} (Typical) to the first Access ^[10]	1		1		1		ms
Clock								
t _{CYC}	Clock Cycle Time	4.0		5.0		6.0		ns
t _{CH}	Clock HIGH	1.8		2.0		2.4		ns
t _{CL}	Clock LOW	1.8		2.0		2.4		ns
Output Times								
t _{CO}	Data Output Valid After CLK Rise		2.8		3.0		3.5	ns
t _{DOH}	Data Output Hold After CLK Rise	1.25		1.25		1.25		ns
t _{CLZ}	Clock to Low-Z ^[11, 12, 13]	1.25		1.25		1.25		ns
t _{CHZ}	Clock to High-Z ^[11, 12, 13]	1.25	2.8	1.25	3.0	1.25	3.5	ns
t _{OEV}	\overline{OE} LOW to Output Valid		2.8		3.0		3.5	ns
t _{OELZ}	\overline{OE} LOW to Output Low-Z ^[11, 12, 13]	0		0		0		ns
t _{OEHZ}	\overline{OE} HIGH to Output High-Z ^[11, 12, 13]		2.8		3.0		3.5	ns
Set-up Times								
t _{AS}	Address Set-up Before CLK Rise	1.4		1.5		1.5		ns
t _{ADS}	\overline{ADSC} , \overline{ADSP} Set-up Before CLK Rise	1.4		1.5		1.5		ns
t _{ADVS}	\overline{ADV} Set-up Before CLK Rise	1.4		1.5		1.5		ns
t _{WES}	\overline{GW} , \overline{BWE} , \overline{BW}_X Set-up Before CLK Rise	1.4		1.5		1.5		ns
t _{DS}	Data Input Set-up Before CLK Rise	1.4		1.5		1.5		ns
t _{CES}	Chip Enable Set-up Before CLK Rise	1.4		1.5		1.5		ns
Hold Times								
t _{AH}	Address Hold After CLK Rise	0.4		0.5		0.5		ns
t _{ADH}	\overline{ADSP} , \overline{ADSC} Hold After CLK Rise	0.4		0.5		0.5		ns
t _{ADVH}	\overline{ADV} Hold After CLK Rise	0.4		0.5		0.5		ns
t _{WEH}	\overline{GW} , \overline{BWE} , \overline{BW}_X Hold After CLK Rise	0.4		0.5		0.5		ns
t _{DH}	Data Input Hold After CLK Rise	0.4		0.5		0.5		ns
t _{CEH}	Chip Enable Hold After CLK Rise	0.4		0.5		0.5		ns

Notes:

10. This part has a voltage regulator internally; t_{POWER} is the time that the power needs to be supplied above V_{DD}(minimum) initially before a read or write operation can be initiated.
11. t_{CHZ}, t_{CLZ}, t_{OELZ}, and t_{OEHZ} are specified with AC test conditions shown in part (b) of AC Test Loads. Transition is measured ± 200 mV from steady-state voltage.
12. At any given voltage and temperature, t_{OEHZ} is less than t_{OELZ} and t_{CHZ} is less than t_{CLZ} to eliminate bus contention between SRAMs when sharing the same data bus. These specifications do not imply a bus contention condition, but reflect parameters guaranteed over worst case user conditions. Device is designed to achieve High-Z prior to Low-Z under the same system conditions.
13. This parameter is sampled and not 100% tested.
14. Timing reference level is 1.5V when V_{DDQ} = 3.3V and is 1.25V when V_{DDQ} = 2.5V.
15. Test conditions shown in (a) of AC Test Loads unless otherwise noted.

Switching Waveforms

Read Cycle Timing^[16]

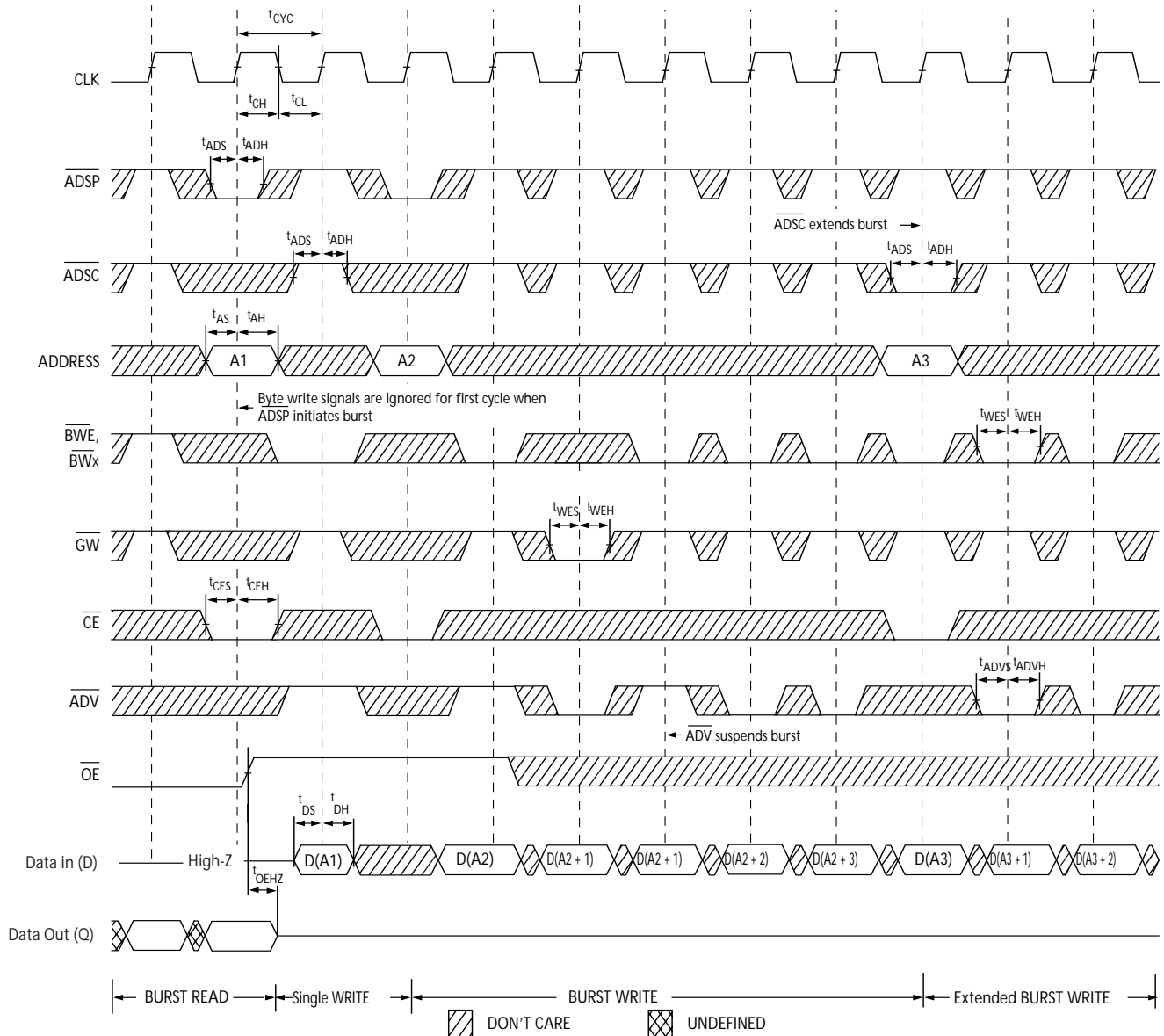


Note:

16. On this diagram, when \overline{CE} is LOW: \overline{CE}_1 is LOW, CE_2 is HIGH and \overline{CE}_3 is LOW. When \overline{CE} is HIGH: \overline{CE}_1 is HIGH or CE_2 is LOW or \overline{CE}_3 is HIGH.

Switching Waveforms (continued)

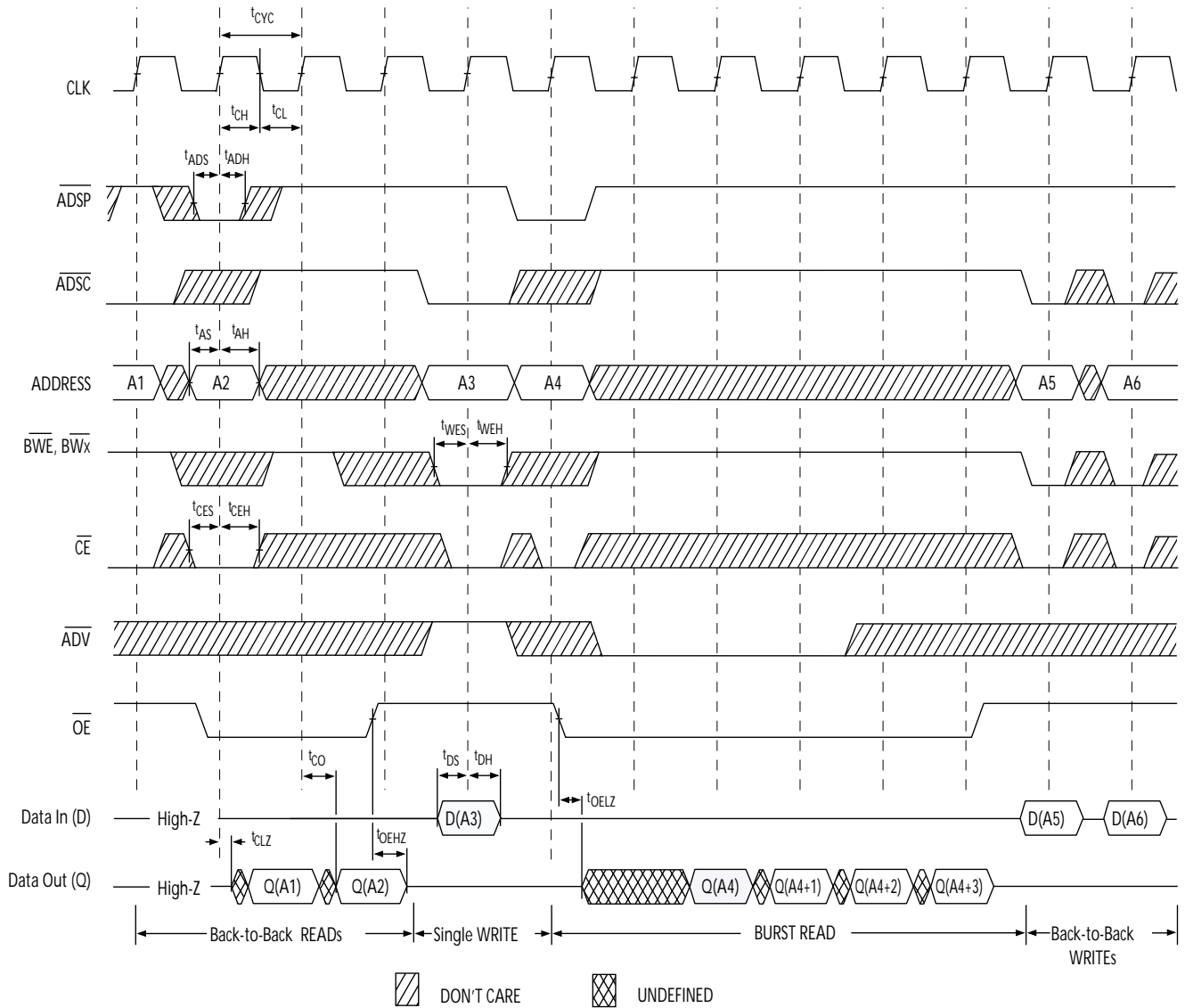
Write Cycle Timing^[16, 17]



Note:

17. Full width write can be initiated by either \overline{GW} LOW; or by \overline{GW} HIGH, \overline{BWE} LOW and \overline{BW}_x LOW.

Switching Waveforms (continued)
Read/Write Cycle Timing^[16, 18, 19]

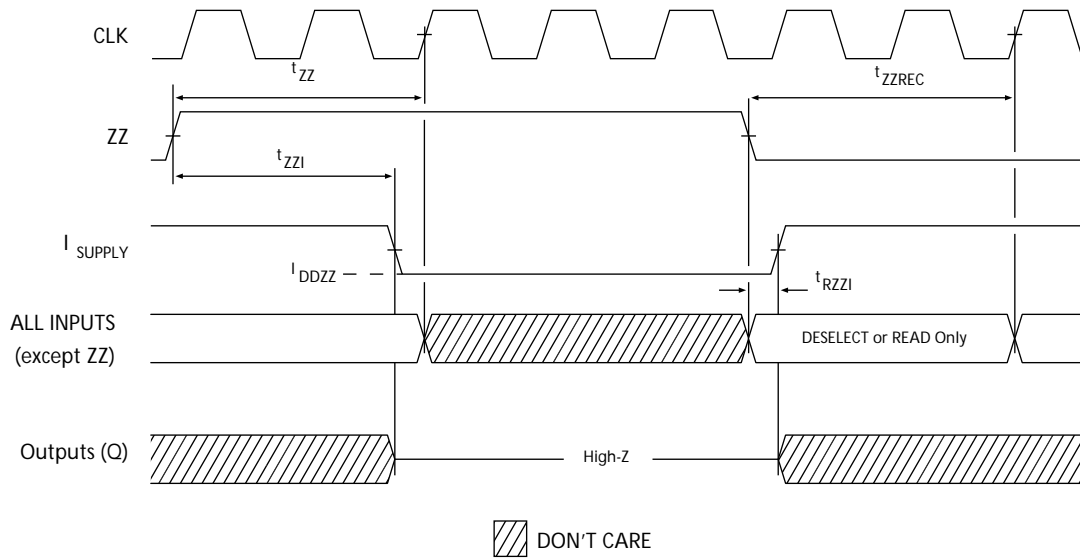


Notes:

- 18. The data bus (Q) remains in high-Z following a WRITE cycle, unless a new read access is initiated by \overline{ADSP} or \overline{ADSC} .
- 19. GW is HIGH.

Switching Waveforms (continued)

ZZ Mode Timing^[20, 21]



Notes:

- 20. Device must be deselected when entering ZZ mode. See Cycle Descriptions table for all possible signal conditions to deselect the device.
- 21. DQs are in high-Z when exiting ZZ sleep mode.

Ordering Information

Not all of the speed, package and temperature ranges are available. Please contact your local sales representative or visit www.cypress.com for actual products offered.

Speed (MHz)	Ordering Code	Package Diagram	Part and Package Type	Operating Range	
166	CY7C1366C-166AXC	51-85050	100-pin Thin Quad Flat Pack (14 x 20 x 1.4 mm) Lead-Free	Commercial	
	CY7C1367C-166AXC				
	CY7C1366C-166BGC	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm)		
	CY7C1367C-166BGC				
	CY7C1366C-166BGXC	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm) Lead-Free		
	CY7C1367C-166BGXC				
	CY7C1366C-166BZC	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm)		
	CY7C1367C-166BZC				
	CY7C1366C-166BZXC	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm) Lead-Free		
	CY7C1367C-166BZXC				
	CY7C1366C-166AXI	51-85050	100-pin Thin Quad Flat Pack (14 x 20 x 1.4 mm) Lead-Free		Industrial
	CY7C1367C-166AXI				
	CY7C1366C-166BGI	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm)		
	CY7C1367C-166BGI				
	CY7C1366C-166BGXI	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm) Lead-Free		
	CY7C1367C-166BGXI				
CY7C1366C-166BZI	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm)			
CY7C1367C-166BZI					
CY7C1366C-166BZXI	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm) Lead-Free			
CY7C1367C-166BZXI					
200	CY7C1366C-200AXC	51-85050	100-pin Thin Quad Flat Pack (14 x 20 x 1.4 mm) Lead-Free	Commercial	
	CY7C1367C-200AXC				
	CY7C1366C-200BGC	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm)		
	CY7C1367C-200BGC				
	CY7C1366C-200BGXC	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm) Lead-Free		
	CY7C1367C-200BGXC				
	CY7C1366C-200BZC	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm)		
	CY7C1367C-200BZC				
	CY7C1366C-200BZXC	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm) Lead-Free		
	CY7C1367C-200BZXC				
	CY7C1366C-200AXI	51-85050	100-pin Thin Quad Flat Pack (14 x 20 x 1.4 mm) Lead-Free		Industrial
	CY7C1367C-200AXI				
	CY7C1366C-200BGI	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm)		
	CY7C1367C-200BGI				
	CY7C1366C-200BGXI	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm) Lead-Free		
	CY7C1367C-200BGXI				
CY7C1366C-200BZI	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm)			
CY7C1367C-200BZI					
CY7C1366C-200BZXI	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm) Lead-Free			
CY7C1367C-200BZXI					

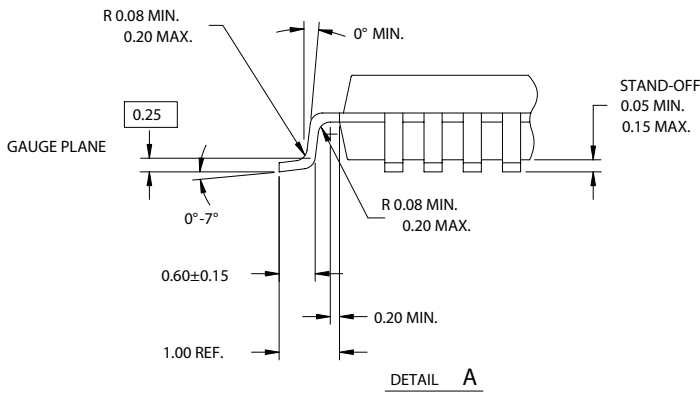
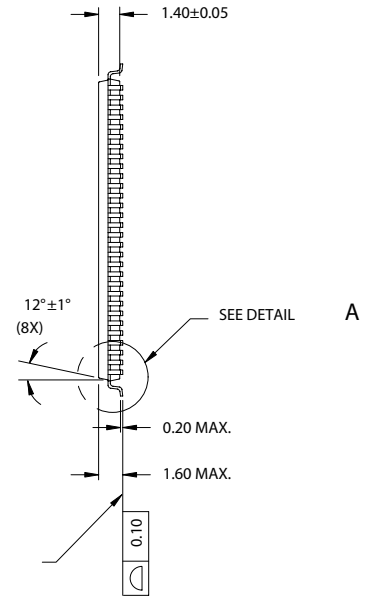
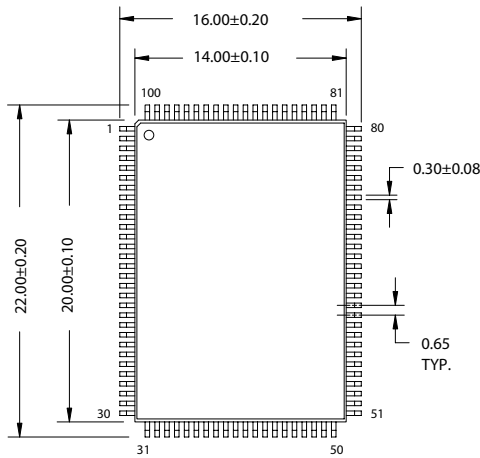
Ordering Information (continued)

Not all of the speed, package and temperature ranges are available. Please contact your local sales representative or visit www.cypress.com for actual products offered.

250	CY7C1366C-250AXC	51-85050	100-pin Thin Quad Flat Pack (14 x 20 x 1.4 mm) Lead-Free	Commercial
	CY7C1367C-250AXC			
	CY7C1366C-250BGC	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm)	
	CY7C1367C-250BGC			
	CY7C1366C-250BGXC	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm) Lead-Free	
	CY7C1367C-250BGXC			
	CY7C1366C-250BZC	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm)	
	CY7C1367C-250BZC			
	CY7C1366C-250BZXC	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm) Lead-Free	
CY7C1367C-250BZXC				
250	CY7C1366C-250AXI	51-85050	100-pin Thin Quad Flat Pack (14 x 20 x 1.4 mm) Lead-Free	Industrial
	CY7C1367C-250AXI			
	CY7C1366C-250BGI	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm)	
	CY7C1367C-250BGI			
	CY7C1366C-250BGXI	51-85115	119-ball Ball Grid Array (14 x 22 x 2.4 mm) Lead-Free	
	CY7C1367C-250BGXI			
	CY7C1366C-250BZI	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm)	
	CY7C1367C-250BZI			
	CY7C1366C-250BZXI	51-85180	165-ball Fine-Pitch Ball Grid Array (13 x 15 x 1.4 mm) Lead-Free	
CY7C1367C-250BZXI				

Package Diagrams

100-Pin Thin Plastic Quad Flatpack (14 x 20 x 1.4 mm) (51-85050)

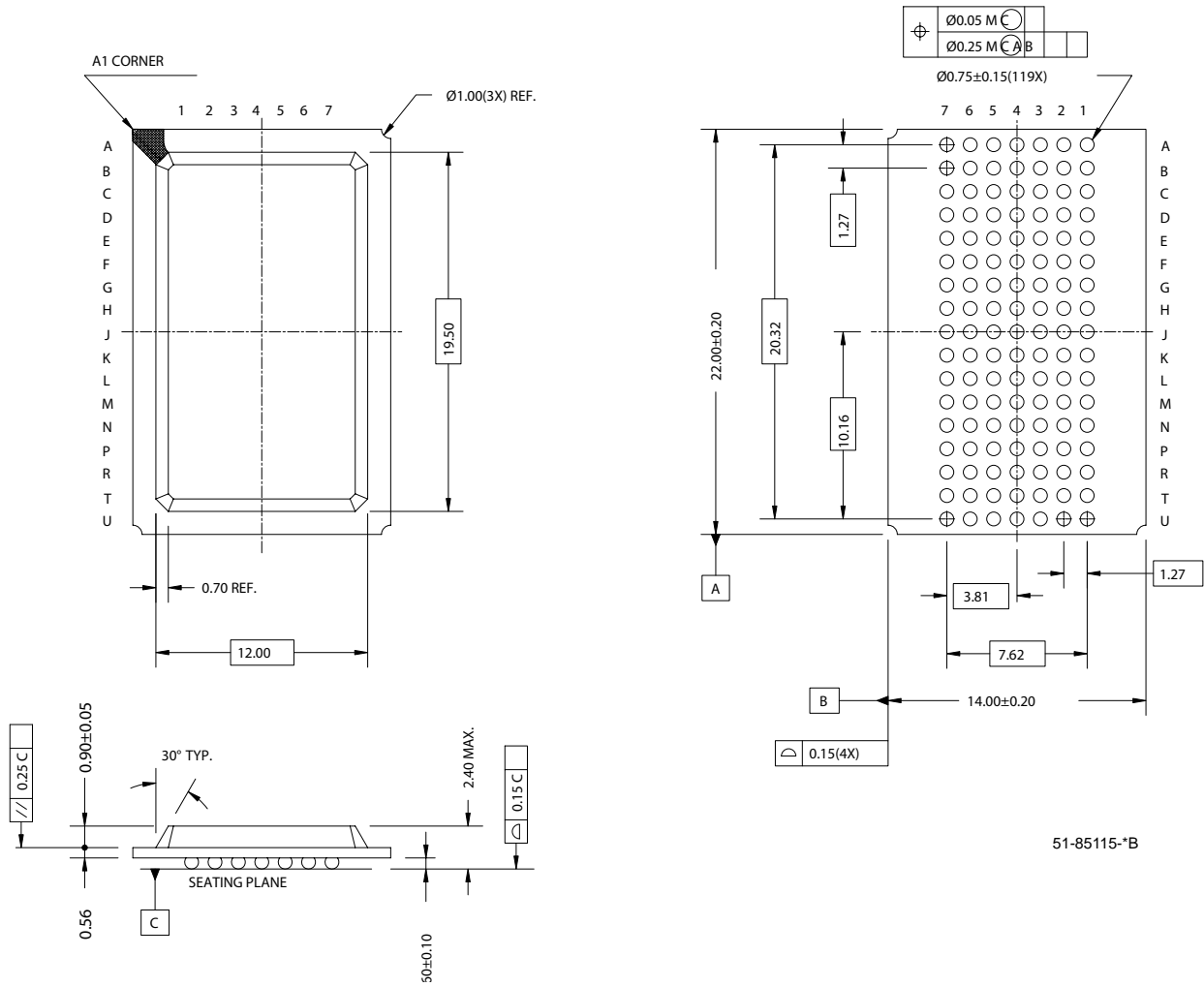


- NOTE:
1. JEDEC STD REF MS-026
 2. BODY LENGTH DIMENSION DOES NOT INCLUDE MOLD PROTRUSION/END FLASH
MOLD PROTRUSION/END FLASH SHALL NOT EXCEED 0.0098 in (0.25 mm) PER SIDE
BODY LENGTH DIMENSIONS ARE MAX PLASTIC BODY SIZE INCLUDING MOLD MISMATCH
 3. DIMENSIONS IN MILLIMETERS

51-85050-*B

Package Diagrams (continued)

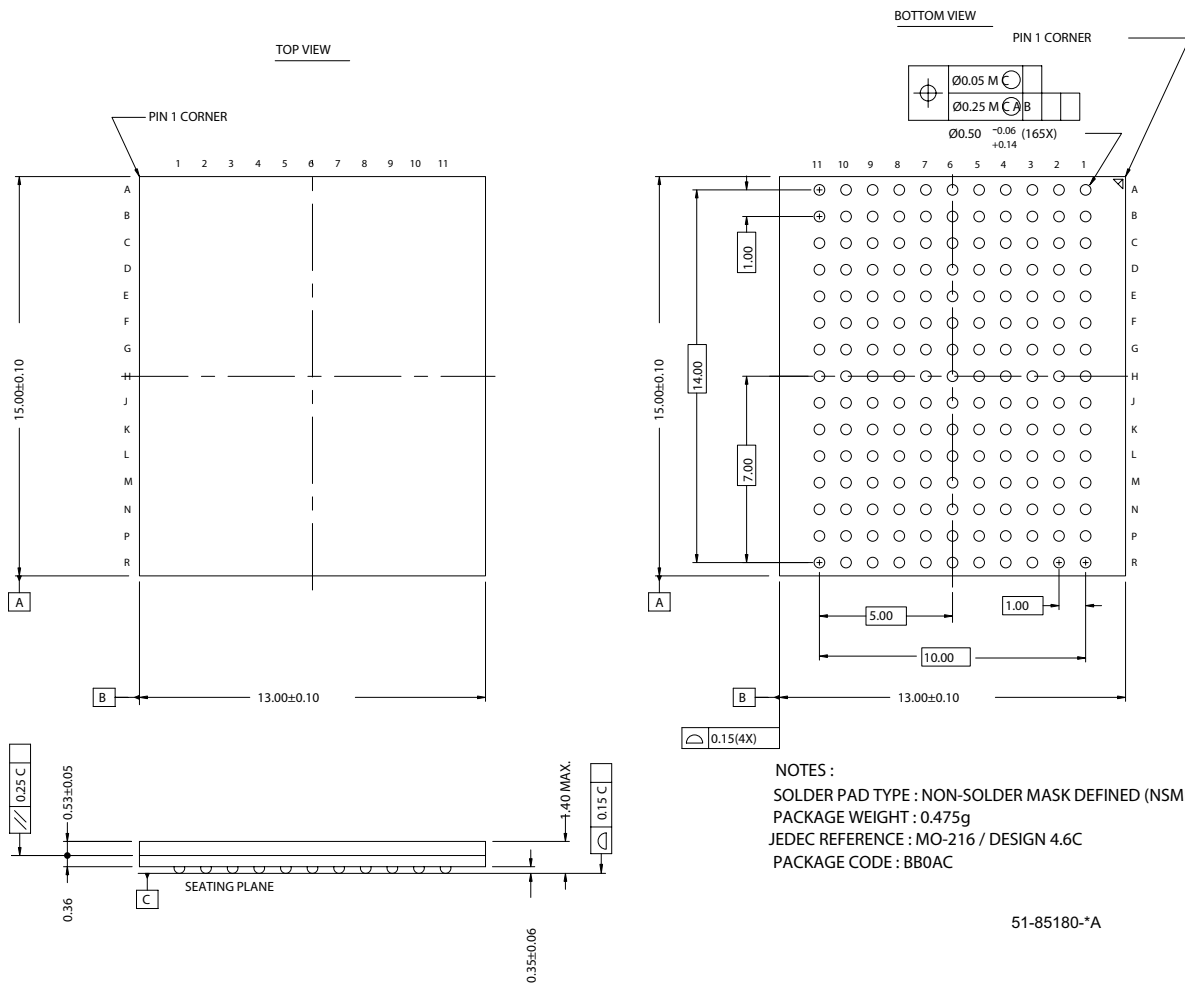
119-Ball BGA (14 x 22 x 2.4 mm) (51-85115)



51-85115-B

Package Diagrams (continued)

165-Ball FBGA (13 x 15 x 1.4 mm) (51-85180)



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Document History Page

Document Title: CY7C1366C/CY7C1367C 9-Mbit (256K x 36/512K x 18) Pipelined DCD Sync SRAM				
Document Number: 38-05542				
REV.	ECN NO.	Issue Date	Orig. of Change	Description of Change
**	241690	See ECN	RKF	New data sheet
*A	278969	See ECN	RKF	Changed Boundary Scan order to match the B rev of these devices
*B	332059	See ECN	PCI	<p>Changed 225-MHz to 250 MHz Speed bins</p> <p>Changed t_{CYC} for 250 MHz from 4.4 ns to 4.0 ns</p> <p>Unshaded 200 and 166 MHz speed bins in the AC/DC Table and Selection Guide</p> <p>Address expansion pins/balls in the pinouts for all packages are modified as per JEDEC standard</p> <p>Added Address Expansion pins in the Pin Definitions Table</p> <p>Changed Device Width (23:18) for 119-BGA from 000110 to 101110</p> <p>Added separate row for 165 -FBGA Device Width (23:18)</p> <p>Included ZZ Mode Electrical Characteristics table</p> <p>Modified V_{OL}, V_{OH} test conditions</p> <p>Changed I_{DDZZ} from 35 mA to 50 mA</p> <p>Changed I_{SB1} from 50 mA to 130, 120 and 110 mA for 250, 200 and 166 MHz</p> <p>Changed I_{SB3} from 50 mA to 120, 110 and 100 mA for 250, 200 and 166 MHz</p> <p>Changed θ_{JA} and θ_{JC} from 25 and 9 °C/W to 29.41 and 6.31 °C/W respectively for 100 TQFP Package</p> <p>Changed θ_{JA} and θ_{JC} from 25 and 6 °C/W to 34.1 and 14.0 °C/W respectively for 119 BGA Package</p> <p>Changed θ_{JA} and θ_{JC} from 27 and 6 °C/W to 16.8 and 3.0 °C/W respectively for 165 FBGA Package</p> <p>Added lead-free information for 100-pin TQFP, 119 BGA and 165 FBGA packages</p> <p>Updated Ordering Information Table</p>
*C	377095	See ECN	PCI	<p>Changed I_{SB2} from 30 to 40 mA</p> <p>Modified test condition in note# 8 from $V_{IH} \leq V_{DD}$ to $V_{IH} < V_{DD}$</p>
*D	408298	See ECN	RXU	<p>Changed address of Cypress Semiconductor Corporation on Page# 1 from "3901 North First Street" to "198 Champion Court"</p> <p>Converted from Preliminary to Final</p> <p>Modified "Input Load" to "Input Leakage Current except ZZ and MODE" in the Electrical Characteristics Table</p> <p>Replaced Package Name column with Package Diagram in the Ordering Information table</p> <p>Updated the ordering information</p>
*E	501793	See ECN	VKN	<p>Added the Maximum Rating for Supply Voltage on V_{DDQ} Relative to GND.</p> <p>Changed t_{TH}, t_{TL} from 25 ns to 20 ns and t_{DOV} from 5 ns to 10 ns in TAP AC Switching Characteristics table.</p> <p>Updated the Ordering Information table.</p>